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EDITORIAL

OBSERVATIONS ON THE HEALTH OF LIVESTOCK

In this number of The Veterinary Journal we publish an article on some carefully made observations on a herd of dairy cows. The information adds to our knowledge of some of the salient features of healthy animals and the variations that may be expected. It also emphasises the effect of simple changes in management, environment, etc., on the various natural processes. It happens too often in carrying out observations on the "normal" animal and those under observation following a line of treatment that too little attention is paid to detail, with the result that the full effect of the treatment may be missed. The observations recorded in the article were carried out in a manner for which the authors are to be congratulated, and it is hoped that they will have the opportunity of extending their work and of placing further results on record.

We have from time to time drawn the attention of our readers to the importance of a knowledge of animals in health. It is true that there are cardinal signs of health which few of us are likely to miss in our examination. When we realise, however, that some disease conditions in livestock may be the result of the long standing application of such treatments as deficiencies in some of the trace elements, and that the symptoms and lesions associated with them do not appear suddenly, it behoves us to acquire all the available knowledge of signs and health and departure from it. We live in an age of preventive medicine. For some diseases, especially those of a specific nature, we have means at our disposal for arresting their spread once their presence has been diagnosed. Our information on some such diseases is fairly complete; with others, we have still some way to go before we can feel in a safe position. The time will come when methods of therapy will be better understood for the control of the recognised diseases. There still remains, however, the large number of animals not apparently in a state of perfect health, the nature of the cause of which is but imperfectly understood. It is essential, therefore, that we should be able to recognise the earliest signs of departure from health so that we may be in a position to attempt to rectify deficiencies, etc., before the majority of the animals in the

herd or flock are involved. By careful examination of a group of animals from time to time, taking note of the outstanding features associated with healthy stock, and making comparisons at each examination it may be possible to arrive at a conclusion that the general state of health in the group is being maintained or has deteriorated. There never was a time so important as the present when the necessity for the early recognition of ill-health or deterioration in health was necessary. Early recognition of disease, be it specific or otherwise, early diagnosis of the cause where possible, and the early application of remedial or preventive measures will go far to maintain our livestock in a flourishing condition with the consequent higher yield of milk and meat. The periodic examination of livestock is being encouraged throughout the country; the more we are acquainted with the cardinal signs of health and the earliest evidence of departure from health, the greater service will we be to the agricultural community and to the country.

General Articles

THE HEALTH OF DAIRY CATTLE: OBSERVATIONS ON AYRSHIRE COWS UTILISED AS THE SUBJECT OF A NUTRITIONAL EXPERIMENT

(Aberdeenshire, August-October, 1941)

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Introduction

DURING the period August 18 to October 12, 1941, certain selected pure Ayrshire and Dairy Shorthorn-Ayrshire cross cows from a farm in Aberdeenshire were utilised in a nutritional experiment. The routine observations were carried out by A.N.W. and P.G.M., while J.C.G. acted as visiting veterinary surgeon and inspected all animals at least twice weekly. It was felt that an excellent opportunity had arisen to take an extensive series of observations bearing upon the general health and well-being of the animals. Observations were limited to a certain extent by the fact that it was considered undesirable, in the interests of the experiment, to handle the animals unduly. Rectal and vaginal examinations were not, therefore, carried out nor were any attempts made to record blood pressures or to withdraw samples of blood or other internal body fluids. Certain observa-

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tions were carried out in strict accordance with pre-arranged instructions: these were, morning and afternoon rectal temperatures, morning respiration rate, evening heart rate, daily milk yield, weekly pooled milk composition, initial and final live weights, skin thickness measurements, and a weekly test of irritability. The other data, which are recorded below, were based upon methods of observation devised by the present authors.

The animals were arranged in different groups, and for part of the experimental period were subjected to different treatments. In the case of all values recorded in this paper, however, there were not any significant differences between those of different groups, including the normal controls. It is not suggested that the figures obtained necessarily represent normal ranges or normal means for this breed of dairy cattle, but it is strongly felt that, without some such comprehensive studies, it is not possible to assess the true significance of a nutritional experiment involving this species.

In addition to the physiological observations, records were made of the geographical and constructional features of the farm and farm-buildings, and of the subsoil, composition and quality of the pastures. Meteorological data were taken, with the kind co-operation of Miss Sadie M. Smith, B.Sc., from the local observation station.

The present paper contains, from considerations of space, selections and summaries only of the somewhat voluminous records which were collected, but all data are being filed for reference, as it is hoped to pursue the subject further when suitable opportunities arise.

Feeding and Management

The herd from which these animals were selected normally comprises about 115-120 lactating or dry milch cows. Details of the byre and pastures are given in the accompanying tables. The normal calving practice is as follows: as soon as they are dried off, the cows are either (summer-time) grazed on hill pastures or else (winter) tied up on an outlying farm; they are brought back to the home farm about six weeks before they are due to calve, and from then on they receive 6 lbs. of concentrates per day. Calving takes place either in the field referred to or in a spare byre; if it occurs in the field the animal is immediately brought in to the spare byre and the calf is taken away at once. The cow is moved in to one of the milking byres three days after she has calved and her milk is used for human consumption as from the seventh milking, provided that the colour of the milk is satisfactory. Cows are usually served at about nine weeks after calving (single service).

Up to the present time, heifer calves have normally received milk from the pail up to about ten weeks of age, concentrates being fed in addition as early as possible. It has been found that such calves can eat small quantities of bruised oats, provided they are fed from the same pail as that used for the milk, during the second week of life. After ten weeks the calves normally receive some mechanically-separated milk and, by that time, are eating about 2 lbs. of concentrates per day. During their first year, the heifer calves are kept indoors in summer-time and in courts all winter. As yearlings they are

allowed to graze mostly on hill pastures and, during their second winter, they receive a small amount of concentrates but are fed mostly on turnips or silage scattered in the fields, a small quantity of hay once daily, and oat straw *ad libitum*. During their second summer, they receive grazing only and are served so as to calve, if possible, at about thirty months of age.

The lactating cows, including all those utilised in the experiment, were turned out to bare pasture (fields 69, 70) on 13.5.41, after a normal winter housing period of six months, during which time they had been fed mostly on silage with some concentrates. They still received some turnips in the byres at mid-day before being turned out to first-year's grass (fields 8, 9) on 22.5.41 from 7 to 9 a.m. and from 6 to 8 p.m. From this date onwards, they lay out overnight in bare pasture (fields 86, 2). This routine was continued until 2.6.41, when the cows were fed indoors on cut grass allowed *ad libitum* (actual consumption about 150-160 lbs. per day). As from 12.7.41, they received very good quality aftermath, i.e., second cut grass. This was continued until 16.8.41, when supplies of cut grass became inadequate and the cows were returned to grazing. They still came in at mid-day to receive a feed of about 50 lbs. per head cut grass, and were again turned out to pasture before the afternoon milking.

The initial control period of the experiment began on 18.8.41, the cows being divided into groups as previously arranged. Cows Nos. 17, 24, 39, 40, 48, 63, 67, 70, 77, 90 and 94 were placed in byre 1 and cows Nos. 1, 16, 35, 36, 47, 54, 55, 71, 86, 87, 96, 97, 102, 104 and 105 in byre 2. From this date, all cows in the experiment were allowed 1 lb. per head daily of National dairy cake. As from 22.8.41, those experimental animals yielding sufficient milk were fed on the production basis normally adopted by the farm management, i.e., 4 lbs. of cake was allowed to each cow producing over 2 gallons of milk. This was in addition to the 1 lb. which was being fed on account of the experiment. As from 23.8.41, approximately 35 lbs. per head daily of green oats were allowed in place of the cut grass. Up till 29.8.41, the animals in byre 1 were grazed in field 9 and those in byre 2 were grazed in field 8; on this date the experimental period proper began. Certain concentrated foods were substituted pound for pound in the rations and the animals were thereafter grazed together in field 13. After the usual disturbances resulting from strangeness, the animals all settled down to graze normally. On 17.9.41 all animals were placed on a winter diet, concentrates being fed thereafter at the rate of 4 lbs. for each gallon after the first. The concentrated ration fed consisted of bran 2 parts, bruised oats 1 part, coconut cake 1½ lbs., and chalk at the rate of 20 lbs. per ton. On 17.9.41 the animals were shifted to field 70 for a period of one week. During this period (on 21.9.41) the last feed of special experimental cake was given; it was thereafter (final control period) replaced pound for pound by the above mixture. On 23.9.41, owing to a breakdown of the cut-lift, all animals were fed 30 lbs. per head of marrow-stem kale in place of cut grass. Nos. 48, 70 and 90 left about half of this first meal of kale, whereas the remainder cleared it up entirely. On the next day the allowance of kale was increased to 60 lbs., and, in addition, each animal was allowed per day 60 lbs. of cut grass, 6 lbs. of hay and 4 lbs. of meal mixture for every gallon of milk over the first 1½. By this date the pastures were very bare indeed—1941 has perhaps been the worst local grazing season for many

years—and the animals were, therefore, brought in at 10 a.m. G.M.T. for their feed of grass and kept indoors until after the afternoon milking. Half of the kale and half the concentrated ration were fed at 2 p.m. G.M.T., the remainder having been given before the morning milking. As from 29.9.41 until the end of the final control period (12.10.41), the animals were housed overnight, their only period outside the byre being from immediately after the morning milking until 10 a.m. G.M.T., when they were grazed on fields 1 and 77, which comprised clean land oat stubble. Cut grass was no longer fed after this date, although the kale and hay were supplied as before. Throughout the whole period of the experiment the morning and afternoon milkings were commenced at 3.30 a.m. and 2.45 p.m. G.M.T. respectively.

Illness

Under this heading are recorded the few cases of frank illness which occurred in the experimental or neighbouring animals: the heading "disease," as opposed to "health" or "good health," has been avoided in view of the scope of the paper.

The herd as a whole appeared to be relatively lightly affected by the "major diseases of cattle." There were no positive reactors to the tuberculin test, and contagious abortion had been absent from the herd for many years. Occasional cases of Johne's disease had occurred, and during our period of observation one of the non-experimental animals developed characteristic symptoms of this malady and was immediately slaughtered. Apart from the transient type of inflammation, locally known as "weed," there was little evidence of clinical streptococcal mastitis. The breeding record appeared to be good, and in two or three cases only out of the whole herd was there any indication of impaired fertility.

It is probably true to say that, once the major disorders of cattle have been controlled, the incidence of minor maladies tends to decrease in most instances. In the present herd, however, there seems to have been no such decrease. Several cases of "milk fever" occurred in the non-experimental animals and were successfully treated by subcutaneous injections of calcium borogluconate. The most serious illness was, however, "foul of the foot," which affected two of our animals (35 and 105) quite seriously, and another (96), together with a non-experimental animal, to a lesser degree. Cow 105 had suffered from the same condition during her first lactation, which had had to be closed when she was still yielding 27½ lbs. of milk daily. She was still a little lame at the time of her second calving, and on 18.9.41 the condition flared up to such a degree that she had to remain under constant treatment throughout the remainder of the experimental period. It was not possible in her case to make any pasture observations. Cow 35 developed the condition in acute form as from 11.9.41, and remained a severe clinical case until the end of the experimental period; several of her "physiological" records were materially affected thereby. Cow 96 also developed the condition but responded to early treatment.

"Foul of the foot" is a form of bacterial necrosis which, on clinical grounds, appears to be analogous to "foot-rot" in sheep. At the same time, cattle are stated to be insusceptible to the ovine infection (Beveridge, 1941,

annotated by Francis, 1941). Whatever its ætiology, the condition may prove a serious source of loss in dairy herds, and we suggest that a study of the factors governing its development and control would be of enormous importance to the dairy industry.

The remaining disorders were due mainly to injury, which is a constant liability in animals of the Ayrshire breed.

Rectal Temperature

This was recorded twice daily during the morning and afternoon milking times and was carried out with the aid of 30-second clinical thermometers (N.P.L. tested) and a stop-watch). The thermometer was inserted for one minute and every effort was made to ensure that its bulb was in full contact with the rectal mucosa. Whenever necessary, a finger was introduced through the animal's anal sphincter and the end of the bulb held in position as advised by Professor Wm. C. Miller (R.V.C., London). By this means it was possible to avoid the false results which are obtained when the bulb lodges in fæcal material or the rectum "balloons." Notwithstanding these precautions, repeated observations were frequently found to be necessary, the indications being usually that the rectal temperature first recorded differed quite markedly from a vaginal temperature taken immediately before or afterwards. It was with some surprise that we noted that Benedict (1936) recorded the "true body" temperature of the elephant by *subtraction* of 1.3 deg. Fahr. from the value recorded by lodgment of the bulb of the thermometer within a freshly-passed fæcal mass. (See original for a full discussion.) Although conditions may differ from species to species, there is no doubt that, in these particular dairy cows, the temperature of the fæcal material was considerably below that of the rectal mucosa; this we were able to show time and again to our own satisfaction.

The results obtained may be seen in the accompanying tables and it is interesting to compare them with the figures quoted by other authors, and in particular those of Wooldridge (1905). Most text-books (e.g., Marshall and Halnan, 1932; Miller, 1935) give the average rectal temperature of the ox as lying between 100 and 102 deg. Fahr., although Larson and Putney (1928, p. 322) state that "The [rectal] temperature of a cow ranges from 100 to 103 deg. Fahr. and may go 1 deg. above or below these figures without causing worry. Each individual seems to have a temperature peculiar to itself." Ritzman and Benedict (1938), who carried out long-term observations upon seven Holstein and four Jersey cows, stress the remarkable constancy of the rectal temperature. The highest rectal temperature which they recorded was 39.0 deg. Cent. (102.2 deg. Fahr.); the lowest was 37.2 deg. Cent. (99.0 deg. Fahr.) and the mean, which was based upon about 1,000 individual records, was 38.2 deg. Cent. (100.8 deg. Fahr.). Under the conditions of the present experiment the morning temperatures were almost always between 99.8 and 101.6 deg. Fahr. (range of means 100.4 to 101.0 deg. Fahr.), while the afternoon temperatures were, with few exceptions, between 100.0 and 102.0 deg. Fahr. (range of means 100.8 to 101.5 deg. Fahr.). In one case only did the temperature of an otherwise clinically normal animal rise appreciably above 102 deg. Fahr. This was cow

No. 24, which, on 9.9.41, showed morning and afternoon temperatures of 103.1 and 103.5 deg. Fahr. respectively. The reason for this discrepancy was not apparent, as the animal fed and milked normally.

Vaginal Temperature

This also was recorded at the morning and afternoon milking times with the aid of the same clinical thermometers as were used in the case of the rectal temperatures. The standard observational period was again one minute but it was repeatedly shown that, in every case in which a true *vaginal* temperature was taken, the correct reading could be obtained easily within a 30-second period. There appears to us to be no doubt as to the superiority of the vaginal over the rectal method in the case of the non-œstral animal, always providing that full care is taken to insert the bulb of the thermometer within the vagina itself and not to record the vulvar or vestibular temperature, which is often lower by as much as 0.5 deg. Fahr. A thermometer with a stem considerably longer than that of the commonly used type would be desirable. In very few instances only was the recorded vaginal temperature found to be lower than the recorded rectal temperature and, in these cases, the differences were of the order of but 0.1 to 0.3 deg. Fahr., whereas, as is indicated above, the first recorded rectal temperature was frequently found to be as much as a whole degree below the recorded vaginal temperature. In these last instances, repeat observations indicated that the recorded vaginal temperature was the "correct" one. The word "correct" is used with some reservation because, as pointed out by Kriss (1921), such measurements should be taken more deeply into the rectum or vagina than is normally practised. While we do not feel in a position to criticise adversely the more intensive observations of Kriss, we must put it on record that we found no indication, by ordinary clinical standards, that a properly taken vaginal temperature was lower than a properly taken rectal one. The bulb of our thermometer was, however, inserted to a depth of less than six inches which, according to Kriss, is the minimum distance for recording a reliable body temperature. Nevertheless, we took stringent precautions to ensure that the bulb of the thermometer was in full proximity to the mucous membrane of either rectum or vagina. It is hoped to take an early opportunity of repeating Kriss's observations, using a considerably greater number of animals than were available for his studies. [At the time of going to press, there have not been any satisfactory replies to the request of one of us (A.N.W., *Vet. Rec.*, Nov. 22, 1941, *53*, 692) for long-stemmed clinical thermometers. If any practitioner or instrument-maker could loan or otherwise let us have such a thermometer, we should be grateful.]

Heart Rate

The heart rate of each animal was recorded once daily, immediately after the afternoon milking. The cows were prepared initially by clipping short the hair of that area of chest-wall immediately behind the left foreleg. The method adopted was to approach the cow quietly, set a stop-watch in motion, and locate the heart-beat with the aid of either a stethoscope or a phonendoscope. When

the stop-watch had reached the full minute, counting was commenced, and the number of beats was recorded over the second full minute. As might have been expected, there was in many instances a slight decrease in rate during the second minute as compared with the first, but in other cases the animal appeared to grow slightly more apprehensive as observations were continued, with the result that the heart rate tended to rise.

It has to be reported that a very remarkable interference on the part of the milking machine was responsible for our failure to record correct heart rates during the first few weeks of the experiment. Our figures, up till the time when we discovered our error, indicated an average range of 39 to 47 beats a minute, with a mean of approximately 43. We were continuously troubled by the double (almost lub-dupp) pulsations of the machine, which was in use on other cows until the whole herd was ready to leave the byre, but the figures obtained by each of us were in such close agreement with those of the others, and with those of Mr. J. D. Loughran, that we accepted them as correct. Furthermore, the pulsation frequency of the machine was distinctly above that which we recorded for the hearts. It was fortunate that we were able on one occasion to record a number of heart rates without interference from the machine, as we were then able to note at once that the true rates were, in most cases, of the order of 60 to .75 per minute, i.e., about 3/2 the rates we had previously recorded. Subsequently we were able to overcome the difficulty by training our ears to cut out the interference, and latterly, when the cows were housed overnight, we made these particular observations after milking had ceased. We are indebted to Mr. J. Lyon, M.R.C.V.S. (Aberdeen), and to Mr. P. Aitken, of the Royal (Dick) Veterinary College, whom we asked to take heart rates with and without the interference of the machine, and who recorded in its presence frequencies of precisely the same order as we ourselves had previously done.

The only rational explanation which we could devise to account for these discrepancies was the possible "cutting out" of certain auricular beats by superimposition of machine vibrations. This, coupled with the emphasis which coincident machine vibration would lend to certain ventricular beats, must have led us to count other ventricular beats as auricular beats. We ourselves were quite at a loss to account for the step-down of three complete beats to two, and referred the question to Dr. Kenneth Craik (Dept. of Psychology, University of Cambridge). Dr. Craik kindly made the following observations:—

(a) It is an established fact that sensory judgments can be affected unconsciously, e.g., in the case of visual images.

(b) The appreciation of a constant rhythm may be upset by superimposition of an external rhythm.

(c) In this case the explanation is not due to difference and summation (i.e., to some such recording as "the frequency of the machine minus the difference between the two frequencies"). This type of effect occurs at much higher frequencies (25 cycles per second or more) only, when a continuous tone impression is obtained. The explanation in this case appears to be that coincident machine-pulsations and heart-beats were recorded as one, and that some of the intermediate pulsations and beats were likewise recorded as one, with average

results as obtained. Not all the non-coincident pulsations and beats could have been recorded separately, or the total count would have been much higher.

After comparing the two instruments with one another and with the naked ear, we were satisfied as to the superiority, under the given conditions, of the phonendoscope over the stethoscope. The phonendoscope end may be fitted in behind the point of the cow's elbow, and in this way the leg itself is not disturbed. The possible effect of moving the animal's leg forward was shown very strikingly in the case of cow 48, the heart rate of which rose to 120 per minute after its left foreleg had been pulled forward by means of a rope.

Our results indicate that, under byre conditions, the average heart rate of the Ayrshire cow is at any rate well over 60 beats per minute (our average mean was 70). This figure is in good agreement with those obtained for other breeds at the remaining centres co-operating in the main nutritional experiment, and it agrees also with the observations of Fuller (1928). Most text-books give figures for the "ox," and the frequencies suggested are usually between 45 and 50 per minute (Smith, 1921; Marshall and Halnan, 1932; Miller, 1935, and others). Larson and Putney (1928, p. 323) state that "The normal pulse of the cow is from 40 to 50 beats per minute, and the respiration rate from 10 to 20 breaths per minute. In general, there is some relation between the two; when the pulse is fast, the respiration is also fast." Our own data, which are recorded in the accompanying tables, indicate heart rate to respiration rate ratios which are in close agreement with those determined in Ayrshire cattle by Fuller (1928). From Fuller's results and from our own there appears to be no question of a ratio of "4 : 1" in the case of housed dairy cattle.

Respiration Rate

This was recorded twice daily during the morning and afternoon milking times, but in each case after the animal had been milked. The observer stood well back on the right side of the animal, and counted flank movements for a period of one minute as recorded by a stop-watch. Remarkable variation in the respiration rate may be seen from the figures in the accompanying tables. The difficulties of recording an accurate value for the respiration rate of an undisturbed Ayrshire cow housed in a milking byre are considerable. The breed is notoriously highly-strung and the least significant noise, such as the opening of the door to the food store, or the slightest inquisitive movement on the part of a neighbour, is sufficient to induce a marked alteration in both the character and the frequency of the respiratory movements. During that part of the experiment in which the animals were not housed overnight, but were brought into the byre shortly before the morning milking time, a decided polypnœa on the part of individual animals was observed. In these cases, respiratory rates of from 55 to 70 or even more were frequently recorded, and the observations were, of course, subsequently repeated at a later time. Even so, the respiratory rate, after the animal had been housed for a period of over two hours, was sometimes in excess of 50 per minute. The vast majority of the recordings from relatively quiet cows standing at ease indicated a respiration rate of between 20 and 30 per minute. This figure held also for the observations made during the afternoon

milking times. As is probably well known, ruminal contractions tend to mask, or, at any rate, render more difficult to observe, the respiratory movements of the left flank of the animal. With practice, however, it was found possible to obtain concordant readings from observation of right and left flanks respectively, and, in the case of three animals (Nos. 35, 70, 96), which were so placed in the standings that their right flanks were adjacent to the walls of the particular byre, it was necessary to take most of the readings from the left flank. The character of the respirations was noted with some interest. Whilst, in many cases, a cow was found to breathe at a relatively even rate over the full minute of observations, in numerous others a rather characteristic rhythm was noted. In this, a period of rapid breathing (50 to 60, or even more per minute) was followed by one in which the respirations were much deeper and slower. This type of breathing was not confined to a few of the animals but was seen in most of them at various times during the experimental period.

Even allowing for the particular byre conditions, our results would suggest that the "normal" frequency of respiration of the dairy cow is somewhat underrated by most standard text-books, which do not in all cases distinguish the dairy from the beef animal, but give average figures for the "ox." Thus Marshall and Halnan (1932) and Miller (1935) cite 12 to 15 or 16 per minute as the normal rate for the species. Dukes (1935) gives 10 to 30 per minute, but Larson and Putney (1928), who deal specifically with the dairy cow, allow only 10 to 20 per minute. It seems clear from the observations of Benedict and Ritzman (1923) that the respiratory rate of the resting steer is very low indeed, even when the animal is interfered with by putting a hand over its muzzle. We do not agree with these authors (1927, p. 142) that a pneumograph is necessary in order to obtain accurate readings. With practice it is possible to obtain highly consistent results and our respective individual observations never once varied from each other by more than one per minute.

Live Weight

The weight of each animal was recorded thrice weekly throughout the experimental period on successive days during the first and last weeks and on alternate weekdays during the remainder of the time. Weighings were commenced at 1 p.m. G.M.T. and were made with the aid of the farm weigh-bridge, which is an accurate instrument built for metabolic studies. The weigh-bridge was carefully zeroed, checked and kept free from excretions while the weights were being taken; any animals showing variations greater than 28 lb., as compared with the initial weights, were at once re-weighed to ensure the absence of clerical errors.

It is a well-known fact that the live weight of ruminants is prone to very marked fluctuations, not only from day to day but from one time of the day to another. The subject has been fully discussed by Benedict and Ritzman (1923, pp. 80 *et seq.*; 1927, pp. 54 *et seq.*) in its special relationship to the steer, and their papers should be consulted by those who wish to acquire a more complete understanding of the factors involved. Our own results are given in the accompanying tables.

XUM

Milk Yield and Milk Composition

The yield of each cow was recorded at both the morning and the evening milkings with the aid of an ordinary spring balance, such as is commonly employed in dairies. Pooled samples, representing three consecutive morning and three consecutive afternoon milkings respectively, were taken each week by aliquots based on the actual yield, and were analysed for percentage butter fat (B.F.) and percentage total solids (T.S.). The percentage B.F. was determined by the Gerber method as outlined in British Standard Specification No. 696, Part I, 1936, and abstracted in the text-book of Wright (1938).

The percentage T.S. was determined by difference after simple drying in an oven at 95 deg. Cent. Duplicate 5 ml. samples were pipetted into prepared crucibles containing asbestos wool, and their wet weight was determined immediately. They were then transferred to the oven for six hours, cooled and re-weighed, and then dried for a further hour to ensure that no further loss had occurred.

The results are recorded in the accompanying tables.

Specific Gravity of the Urine

From 27.9.41 until 12.10.41, during which time the cows were receiving the same diet throughout, samples of urine were taken daily from each experimental animal. Most samples were collected during normal acts of micturition, while the remainder were coaxed from the animals by gently stroking the clitoric region—a method which was not always effective.

Two of the animals (35 and 105) showed some general disturbance during part of the experimental period on account of "foul of the foot." The mean values in these two cases (1035 and 1039 respectively) were above the average of the remaining cows, and the results have, therefore, been summarised with and without them, as follows:—

	Extreme range	*Range of means*	*Average mean*
26 cows (414 readings) ...	1012 - 1049	1017 - 1039	1030
24 cows (381 readings) ...	1012 - 1041	1017 - 1038	1029

Dukes (1935) indicates a range of 1030-1045, with a mean of 1032, for the specific gravity of ox urine. Keitt (1916) apparently reports somewhat lower results for the urine of dairy cattle. Boddie (1933) found the specific gravity of individual samples from normal dairy cows to vary from 1005 to 1050, the average being 1032, and in the case of 24-hour samples, the same author found diurnal variations between 1006 and 1030; he writes: "It is obvious that with a range of specific gravity of this order, the specific gravity of any sample from a sick cow can be of little clinical significance."

Pasture Observations, including Rates of Grazing and of Cudding

On certain days throughout the experimental period, the animals were watched during the whole of the forenoon and early afternoon grazing period. The object was to determine, so far as was possible, the relative amounts of time

spent by each cow in standing or walking, lying, grazing and cudding, and the results should be compared with those of Fuller (1928). Latterly a satisfactory technique was evolved for the recording, not only of these observations, but also of serial estimations of the frequency of grazing (bites) and of cudding. The ideal modification of this technique, which dispenses with the need for a single observer for each animal, would appear to be as follows: one person who knows all the cows intimately should stand or sit at a portable and covered table situated at a point from which the whole of the pasture can be viewed, and should have one assistant, a clock and adequate stationery. Between them, the observer and the assistant should be capable of noting down the times at which an animal commences or ceases to stand or walk, lie, graze or cud, and the number of times it defæcates and urinates. The observer should not be relieved except by another person who has an intimate knowledge of the individual cows. Other assistants, acting singly or in pairs, proceed quietly about the field and obtain a series of counts of the grazing or cudding rate of each animal.

In the present experiment, the rate of grazing (biting) was, with the aid of a stop-watch, recorded over a series of separate minutes. In view of the somewhat complicated jaw and tongue movements of the cow during prehension, it is much better for recording purposes to listen to the swish of the bite of grass as it is plucked away from the sward.

The cudding was recorded in quite straightforward fashion by assistants with stop-watches. The watch was set in motion when a characteristic movement of the cow's throat indicated that the bolus was being regurgitated, and the number of chews was then counted until chewing ceased and the bolus was finally swallowed. A swallowing movement, indicating deglutition of part of the bolus, was frequently noted to occur about half-way through each chewing period. With very little practice it is quite easy to distinguish the true swallowing and regurgitation waves from the other rippling movements which are commonly seen on the necks of cows which are lying at pasture. The actual number of chews per bolus and the frequency of such chewing were, therefore, recorded. It was noted that, during the spells of cudding, the interval between the swallowing of one bolus and the regurgitation of the next was almost always between 2½ and 5 seconds. While systematic counts were not taken, it was noted that chewing took place both on the right and on the left sides of the mouth. One bolus (and usually a series of boluses) was, however, chewed on one side of the mouth alone. (See Brownlee, 1939.)

These pasture observations, which extended over periods of up to eight hours, were not possible without considerable assistance and we are greatly indebted to numerous helpers, including W.L.A. trainees, for their kind and painstaking efforts.

The numerical data are recorded in the accompanying tables. In the case of cudding the average number of bites per bolus and the frequency of chewing are seen to be in close agreement with those of other workers.

So far as we are aware the only comparable figures hitherto recorded for frequency of grazing bites are those of the Cornell University student, who carried out a 24-hours' continuous observation upon beef cattle at pasture. This observer found that the average rate of biting lay between 50 and 70 per minute,

with a maximum of 90 per minute. (This information was contained in an issue of the *New Zealand Farmer Weekly*, and reproduced in the *Aberdeen Bon-Accord and Northern Pictorial* for September 18, 1941.)

[Since this paper was drafted we have received a full account of these observations from Professor D. B. Johnstone-Wallace, formerly Principal of the East Anglian Institute of Agriculture, Chelmsford, Essex, and now head of the Department of Agronomy at Cornell University. The observations were made by Mr. Keith Kennedy, and were included in his Thesis presented last June for the M.S. degree and entitled: "The Influence of the Grazing Habits of Cattle upon the Composition, Consumption and Utilisation of Pasture Herbage." Some of the information has already been published or broadcast in semi-popular form, and a relevant technical communication will appear in due course.

During the summers of 1940 and 1941, accurate records were kept of the behaviour of Aberdeen Angus and Hereford beef cattle during continuous periods of 24 hours, while they were grazing pastures of various types. These investigations showed that cattle continuously on pasture, and not receiving any grain or other supplementary feed, spent an average of approximately eight hours in actual grazing, regardless of the amount of herbage consumed. The grazing period was divided about equally between night and day. Twelve hours out of the 24 were spent by the cattle in lying down, and about seven hours were devoted to chewing the cud. On the pastures in which the investigations were conducted, the cattle walked approximately 2½ miles during the 24 hours, but of this only about ½-mile was walked during the hours of darkness. Beef calves suckled their calves three times a day for approximately 15 minutes on each occasion, and water was taken once only during the day. One animal was found to change positions during her lying periods by getting up and lying down again on nine occasions.

On a pasture containing a dense sward of Kentucky bluegrass and wild white clover about 4 inches to 5 inches in height—giving approximately 4,000 lbs. of green herbage per acre—the cows were able to consume an average of 150 lbs. (32 lbs. dry matter) per 24 hours. While grazing, the animals took from 45 to 90 bites per minute, with an average of about 55. A steady grazing period of up to 30 minutes was observed under favourable conditions. The rate of consumption decreased on pastures in which the herbage was above or below 4 inches to 5 inches in height, and this height appeared to be favoured. One animal was found to deposit 12 droppings of manure, totalling about 40 lbs., during a 24-hour period.

These findings are of practical importance in calculating the nutritional value of the pasture and in determining the best methods of practising rotational or mixed grazing.

We are indebted to Professor H. H. Dukes, D.V.M., for putting us in touch with Professor Johnstone-Wallace.]

Tests of Irritability

The first test was that recommended for use by those responsible for the experimental design, and was carried out according to the technique described by

Dr. S. Bartlett and Mr. K. Blaxter, B.Sc., N.D.A. (N.I.R.D.). On one morning each week the milkers were asked to record the number of times each cow moved her hind feet whilst being stripped.

The second test, devised by ourselves, was to record, by means of a cross against the appropriate figure, each occasion upon which a cow fidgeted when approached or handled for the purpose of recording either the rectal temperature or the heart rate.

The results of the second test especially indicated a characteristic irritability on the part of certain animals. A note of any outstanding result is included in the accompanying tables.

Condition of Fæces

A simple 1-10 scale, as devised by Dr. S. Bartlett at the N.I.R.D., was utilised to record the physical condition of the fæces. By this scale, fæces almost liquid would be recorded as 1 and those which were excessive firm as 10. The assessed intermediate values were recorded at frequent intervals during the experimental period, but the results have not been reproduced in this paper because the fæces of all animals remained normal (values of 4 to 7) throughout.

Skin-fold Thickness

As was made clear in the publication of Rider (1941), the measurement of the thickness of a fold of ox-skin by calipers of the type commonly used in tuberculin-testing is a most inexact method. As a means of recording physiological changes in skin-thickness, therefore, such an instrument leaves much to be desired, and the interesting changes which appeared to take place in the animals under observation must be regarded with due reserve.

Although the subject has not, so far as we are aware, been treated adequately by any one author, it is probably true to say that the following are among the factors causing alteration in the skin thickness of cows :—

(1) *Age.* Heifers and young cows show a greater thickness of skin than mature cows. Old cows show a tendency to increased thickness.

(2) *Seasonal alterations.* In early summer the skin shows a definite decrease on the measurements taken during the winter months. This is a natural physiological change in response to variation in temperatures, exposure to winds and to dampness. Thus, to a large extent, the alteration is affected by the management of the herd.

(3) *Disease.* Chronic infections, whether local or generalised, cause a lowering of the intracellular fat content of the skin and a compensatory increase in the fibrous tissue. A good example of this is seen in liver fluke infestations.

(4) *Breed.*

(5) *Diet.* The importance of this is in relation to the metabolic requirements of the cow. Deficiency in this respect causes, over certain regions of the body, an increase in the skin thickness.

(6) *Milk yield.* The alteration caused by heavy milk yields is, to a certain extent, involved with that of diet, but possibly some undetermined factor,

produced by the extreme demand on the physiological reserves of the cow, is evidenced by an increase in thickness with concomitant decrease in mobility of the skin.

In the course of our observations, five series of measurements were made, each series consisting of three consecutive daily readings of the skinfold thickness at five different sites. The sites chosen were :—

(a) Neck—5 inches in front of the cervical angle of the scapula.

(b) "L.S." and "R.S."—an area over the third last rib and equidistant between the backbone and the mid-ventral line of the body.

(c) Escutcheon—3 inches below the inferior commissure of the vulva.

[(a) and (b) were recorded on both sides of the body.]

In view of the differences between the results of different observers (see Rider, 1941) the figures of P.G.M. only have been utilised in the calculation of the following results (26 animals), which are expressed in mm. :—

Site	*Extreme range*	*Av. max.*	*Av. min.*	*Mean*
Neck (both sides) ...	5.0 - 7.5	6.45	6.23	6.35
L.S. (rib)	8.0 - 14.0	11.70	10.42	11.00
R.S. (rib)	8.0 - 15.0	11.70	10.60	11.00
Escutcheon	6.5 - 10.5	9.10	7.50	7.60

The ratio of neck-fold to rib-fold appeared, from our data, to widen markedly when the health of the animal depreciated. The ratio of neck-fold to escutcheon fold appeared to approximate unity when the animal was in good condition. These points are illustrated by the following three examples :—

(a) *Cow* 70.

Five years of age; average milk yield during 2 months, 14½ lbs. daily; in excellent condition.

Neck	*L.S.*	*R.S.*	*Escutcheon*
7.5	11.5	11.5	7.5

neck : rib = 1 : 1.6; neck : escutcheon = 1 : 1. Skin mobile.

(b) *Cow* 1.

Age 15 years; average milk yield, 20.5 lbs.

Neck	*L.S.*	*R.S.*	*Escutcheon*
6.0	13.0	13.0	8.0

neck : rib = 1 : 2.7; neck : escutcheon = 1 : 1.66. Skin tight.

(c) *Cow* 105.

Four years old; average milk yield, 24 lbs. daily; in poor condition because of a severe attack of "foul of the foot."

Neck	*L.S.*	*R.S.*	*Escutcheon*
6.0	11.5	11.5	8.5

neck : rib = 1 : 1.9; neck : escutcheon = 1 : 1.4. In this case, as in (b), there was a lack of mobility.

As the milk yield declined towards the end of lactation, the general condition of the cow tended to improve in most instances. In these cases, the two skin ratios which have been discussed both tended to approach unity.

Index of Health

(Skin handling properties, alertness, general form, character of mucous membranes)

In assessing the state of health of dairy cows we must necessarily pay tribute to the absence of palpable and visible symptoms of the presence of disease. Any method of examination which avoids undue handling of the animal and does not involve laboratory technique is, therefore, strictly limited in its scope although not in its ultimate value.

With the intention of formulating an index of health for each cow in this experiment, observations were made at four-day intervals throughout the period of 60 days. A value was given for each of four different properties, which were easily assessed without equipment and without interference with the normal activities of the animal.

The condition of the skin, according to its handling properties, is undoubtedly a valuable indication as to the completeness or otherwise of the diet with regard to the cow's metabolic requirements. Extreme age and the presence of chronic disease, e.g., liver fluke infestation, have a tendency to reduce the soft pliability of the skin. In dairy cows, in what is termed " full bloom," the skin presents on palpation a silky pliability and can readily be moved and picked up over the lateral aspects of thorax and abdomen. Such qualities in our assessment were given an arbitrary figure of 10. Any poorness in skin handling properties was indicated by giving a lower figure on a 1-10 scale.

The alertness of a dairy cow can easily be confused with nervous excitability, which depends largely on the breed. Some cows are by nature lethargic while others listen attentively to unusual sounds and watch carefully strangers in the vicinity. Alertness must not, however, be underrated as an indication of the state of health of an individual. Such idiosyncrasies must be taken into account when evaluating it as a measure of health. As in the case of skin-handling properties, an animal showing a completely healthy degree of alertness was allowed 10 marks. Any degree of lassitude was indicated by a lower figure on a similar 1-10 scale.

The visual impression given by any animal in its normal habitat is, to the trained eye, an extremely valuable and accurate indication of its state of health. This visual impression was given the term " general form." Among the many properties involved in this visual impression are those of the appearance of the eyes, " dewy nose," appetite, keenness, desire to groom itself, etc. Again an assessment of 1-10 points was allowed, the highest figure denoting the general form of an animal in complete health.

The examination of the mucous membranes of a cow, viz., those of nostrils, eye, mouth and vagina, involves some interference by handling, but the disturbance is so slight, when the examination is made in a byre with a feeding passage, that it was regarded of little consequence. As in the above observations, the assessment ranged from 1-10 points. Extreme pallor of the mucous membranes was frequently observed in those cows which had a high milk yield and which were obviously utilising all their body resources to this end. Thus, according to the index allowed for the mucous membranes, the cows giving the

best milk yields have a lower assessment than many cows of poorer milking qualities. This would seem to provide further evidence that the continual strain involved by abnormally high milk yields causes a deterioration in the health of our dairy cattle. Correlation of the milk yield with the appearance of the mucous membranes in an animal in an apparently healthy condition might prove to be a useful indication as to the suitability of the diet in fulfilling the requirements of the cow.

According to their relative values, these observations should figure more or less prominently in the final estimation of the "health index." After some deliberation we concluded that the general form of an animal is of considerably greater importance than is the appearance of mucous membranes, and also that alertness and skin-handling properties, while not so important as general form, are more important than mucous membranes and each is equally as valuable as the other. We therefore computed a health index by using the following formula:—

[Alertness (2) + skin handling (2) + general form (3) + mucous membrane (1) = 8.]

The results obtained by the use of this formula appear to be reasonably satisfactory. Owing to poorness of pasture and to other features indicated elsewhere in this paper, the values are rather lower than one would have expected to find in a herd of this type.

Discussion

We have attempted to show that, in assessing the full significance of a nutritional experiment involving dairy (or other) cattle, very much more information might be utilised than appears to have been the case in most instances yet recorded. Such data as those pertaining to live-weight, milk-yield, and economy of food utilisation are, while important in themselves, by no means a complete index of health. It is possible, as has been shown in this experiment, for a cow to be yielding reasonably well and to be maintaining her weight, and yet to give ample evidence to a close observer of a considerable departure from the normal manifestations of good health and well-being. Except in those instances in which an animal serves merely as a "guinea-pig," it is in our opinion absolutely essential to regard every nutritional experiment involving domesticated animals from the viewpoint of sound animal husbandry. Where milk production is concerned, improvement in "performance" is in itself an inadequate index of the true experimental result, because it fails to take into account the subsequent effect upon the cow. The extraordinarily high milk yields which have been obtained under some commercial conditions during recent years have not been brought about without a parallel rise in the incidence of specific and non-specific diseases. A similar state of affairs has followed the excessive forcing of egg-production in poultry, as the recent communication of Dudley, Dobson and Gordon (1941) so clearly shows. The average productive life of a dairy cow in these islands is not greater than 4½ years (Loveday Report, 1938; see also MacGregor, 1941), and in many instances an animal which has given a high yield after its first calf is quite unable to repeat the performance during subse-

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TABLE I

Particulars of the Experimental Animals, with summaries

Animal	Previous Lactations (Yield in gallons, and B.F.)	Heart-Rate (p.m.)	Respiration Rate (a.m.)	Respiration Rate (p.m.)	Ratio Heart : Respn. (p.m.)	Rectal Temp. (a.m.)	Rectal Temp. (p.m.)	Urine Sp. gr.
1 (Ayrshire) Born 30.3.36. Last calving 26.3.41.	578 (3.92%) 503 (4.44%) 966 (4.24%) 1,334 (4.12%) 1,142 (4.22%) 1,225 (4.21%) 1,078 (3.55%) ? ? 1,142 (3.89%) 1,254 (3.85%)	Max.: 79 Min.: 64 Mean: 70.7	Max.: 53 Min.: 21 Mean: 36.8	Max.: 31 Min.: 24 Mean: 30.5	2.64 : 1	Max.: 101.9 Min.: 99.5 Mean: 100.9	Max.: 101.9 Min.: 100.0 Mean: 101.3	Max.: 1038 Min.: 1027 Mean: 1032
16 (Ayrshire) Born 26.9.33. Last calving 5.3.41.	738 (4.31%) 1,003 (3.50%) 1,001 (3.70%) 1,284 (3.60%)	Max.: 78 Min.: 60 Mean: 67	Max.: 40 Min.: 19 Mean: 29	Max.: 41 Min.: 24 Mean: 30	2.23 : 1	Max.: 101.6 Min.: 99.0 Mean: 100.4	Max.: 102.2 Min.: 100.2 Mean: 101.0	Max.: 1036 Min.: 1021 Mean: 1029
17 (Ayrshire) Born 26.12.33. Last calving 15.3.41.	698 (4.31%) 956 (3.44%) 1,067 (3.58%)	Max.: 76 Min.: 59 Mean: 67	Max.: 40 Min.: 17 Mean: 28	Max.: 42 Min.: 22 Mean: 30	2.39 : 1	Max.: 101.5 Min.: 99.3 Mean: 100.5	Max.: 101.8 Min.: 100.5 Mean: 101.2	Max.: 1031 Min.: 1018 Mean: 1024
24 (Dairy Shorthorn-Ayrshire X) Born 1936. Last calving 2.2.41.	3 previous calves (no recording)	Max.: 78 Min.: 60 Mean: 67	Max.: 40 Min.: 24 Mean: 29	Max.: 52 Min.: 24 Mean: 31	2.16 : 1	Max.: 103.1 Min.: 99.8 Mean: 100.7	Max.: 103.5 Min.: 100.1 Mean: 101.3	Max.: 1034 Min.: 1025 Mean: 1027
35 (Dairy Shorthorn-Ayrshire X) Born 1936. Last calving 6.4.41.	3 previous calves (no recording)	Max.: 111 Min.: 62 Mean: 80	Max.: 67 Min.: 19 Mean: 38	Max.: 85 Min.: 24 Mean: 46	1.74 : 1 (N.B., probably much influenced by illness)	Max.: 102.3 Min.: 99.6 Mean: 100.8	Max.: 104.0 Min.: 101.2 Mean: 101.5	Max.: 1049 Min.: 1012 Mean: 1035
36 (Dairy Shorthorn-Ayrshire X) Born 1936. Last calving 9.5.41.	3 previous calves (no recording)	Max.: 80 Min.: 62 Mean: 70	Max.: 42 Min.: 17 Mean: 29	Max.: 40 Min.: 26 Mean: 32	2.19 : 1	Max.: 101.6 Min.: 99.4 Mean: 100.7	Max.: 102.0 Min.: 100.2 Mean: 101.3	Max.: 1041 Min.: 1034 Mean: 1038
39 (Dairy Shorthorn-Ayrshire X) Born 1936. Last calving 23.4.41.	3 previous calves (no recording)	Max.: 92 Min.: 69 Mean: 73	Max.: 45 Min.: 18 Mean: 28.5	Max.: 43 Min.: 43 Mean: 29.5	2.47 : 1	Max.: 101.8 Min.: 100.2 Mean: 100.8	Max.: 101.9 Min.: 100.2 Mean: 101.2	Max.: 1038 Min.: 1031 Mean: 1035
40 (Dairy Shorthorn-Ayrshire X) Born 1936. Last calving 28.5.41.	3 previous calves (no recording)	Max.: 84 Min.: 62 Mean: 67	Max.: 40 Min.: 19 Mean: 29	Max.: 41 Min.: 23 Mean: 30	2.23 : 1	Max.: 101.3 Min.: 99.2 Mean: 100.5	Max.: 102.0 Min.: 99.5 Mean: 101.1	Max.: 1033 Min.: 1028 Mean: 1030

of individual data recorded over an eight weeks' period.

Liveweight (kg.)	Daily Milk Yield (lbs.)	% B.F. (weekly pooled samples)	% T.S. (weekly pooled samples)	Cudding chews/ minute	Cudding chews/ bolus	Grazing Bites (freq/ minute)	Health Index	Remarks
Max.: 445.9 Min.: 408.2 Mean: 430.2	Max.: 30.2 Min.: 13.0	Max.: 5.0 Min.: 3.1	Max.: 13.6 Min.: 12.4	Mean: 59	Mean: 43	Mean: 60	Max.: 4.8 Min.: 3.5	One slipped calf, 1933. Slight mastitis, 4.10.41.
Max.: 463.3 Min.: 378.0 Mean: 396.9	Max.: 35.5 Min.: 18.3	Max.: 4.4 Min.: 3.4	Max.: 13.3 Min.: 12.6	Mean: 63	Mean: 46	Mean: 77	Max.: 7.0 Min.: 5.9	
Max.: 604.2 Min.: 551.1 Mean: 581.4	Max.: 13.8 Min.: 2.5	Max.: 3.0 Min.: 1.3	Max.: 10.2 Min.: 7.6	Mean: 66	Mean: 51	Mean: 80	Max.: 8.1 Min.: 6.1	
Max.: 547.5 Min.: 478.0 Mean: 526.6	Max.: 23.8 Min.: 12.0	Max.: 4.1 Min.: 3.0	Max.: 13.1 Min.: 11.9	Mean: 59	Mean: 51	Mean: 63	Max.: 7.0 Min.: 5.3	
Max.: 538.0 Min.: 484.0 Mean: 530.2	Max.: 30.3 Min.: 9.5	Max.: 4.0 Min.: 3.0	Max.: 12.9 Min.: 11.4	Mean: 56	Mean: 39	Mean: 76	Max.: 5.5 Min.: 4.0	Œdematous s/c swelling above R. F. quarter, 9.9.41. Began to develop "foul of the foot" on 11.9.41 and remained a severe clinical case until end of experimental period.
Max.: 494.0 Min.: 458.6 Mean: 477.2	Max.: 34.3 Min.: 9.5	Max.: 3.7 Min.: 2.6	Max.: 12.5 Min.: 11.4	Mean: 61	Mean: 53	Mean: 68	Max.: 7.0 Min.: 5.0	
Max.: 515.3 Min.: 483.5 Mean: 498.5	Max.: 18.5 Min.: 6.8	Max.: 4.4 Min.: 3.0	Max.: 13.4 Min.: 11.7	Mean: 64	Mean: 43	Mean: 64	Max.: 6.5 Min.: 4.3	Developed an acute abscess on underside of jaw, 10.9.41. For 2-3 days only there was a febrile reaction and a temporary fall in milk yield.
Max.: 561.6 Min.: 516.2 Mean: 533.0	Max.: 34.3 Min.: 19.8	Max.: 4.5 Min.: 2.8	Max.: 13.5 Min.: 11.8	Mean: 68	Mean: 46	Mean: 77	Max.: 7.4 Min.: 5.0	

Continued over

TABLE I—

Animal	Previous Lactations (Yield in gallons, and B.F.)	Heart-Rate (p.m.)	Respiration Rate (a.m.)	Respiration Rate (p.m.)	Ratio Heart : Respn. (p.m.)	Rectal Temp. (a.m.)	Rectal Temp. (p.m.)	Urine Sp. gr.
44 (Ayrshire) Born 14.10.34. Last calving 4.3.41.	1,170 (4.42%) 822 (3.68%) 701 (3.40%)	Max.: 81 Min.: 63 Mean: 74	Max.: 44 Min.: 15 Mean: 28	Max.: 31 Min.: 22 Mean: 28	2.64 : 1	Max.: 101.7 Min.: 99.1 Mean: 100.4	Max.: 102.0 Min.: 99.2 Mean: 101.1	Max.: 1037 Min.: 1022 Mean: 1032
47 (Ayrshire) Born 20.4.35. Last calving 24.12.40 (twins).	1,096 (3.50%) 1,508 (3.23%)	Max.: 80 Min.: 62 Mean: 70	Max.: 42 Min.: 17 Mean: 29	Max.: 32 Min.: 20 Mean: 26.5	2.64 : 1	Max.: 101.6 Min.: 99.2 Mean: 100.5	Max.: 102.0 Min.: 100.6 Mean: 101.1	Max.: 1035 Min.: 1027 Mean: 1030
48 (Ayrshire) Born 19.6.35. Last calving 22.4.41.	1,088 (3.34%) 1,181 (3.25%) 3rd lactation not recorded	Max.: 82 Min.: 64 Mean: 75	Max.: 42 Min.: 19 Mean: 29	Max.: 40 Min.: 19 Mean: 29	2.59 : 1	Max.: 102.0 Min.: 99.6 Mean: 100.9	Max.: 102.2 Min.: 99.8 Mean: 101.3	Max.: 1031 Min.: 1025 Mean: 1028
54 (Ayrshire) Born 4.11.35. Last calving 29.3.41.	614 (3.69%) 895 (3.96%)	Max.: 81 Min.: 60 Mean: 70.5	Max.: 38 Min.: 18 Mean: 27	Max.: 35 Min.: 25 Mean: 28.5	2.47 : 1	Max.: 101.6 Min.: 99.0 Mean: 100.6	Max.: 102.1 Min.: 99.5 Mean: 101.2	Max.: 1040 Min.: 1034 Mean: 1036
63 (Ayrshire) Born 1.3.36. Last calving 23.3.41.	444 (4.15%) 876 (4.06%) 863 (4.16%)	Max.: 77 Min.: 58 Mean: 66	Max.: 44 Min.: 17 Mean: 27	Max.: 43 Min.: 23 Mean: 29	2.28 : 1	Max.: 101.6 Min.: 99.4 Mean: 100.7	Max.: 101.9 Min.: 100.0 Mean: 101.2	Max.: 1037 Min.: 1031 Mean: 1032
67 (Ayrshire) Born 19.4.36. Last calving 7.3.41.	812 (3.68%) 745 (3.02%)	Max.: 80 Min.: 61 Mean: 72	Max.: 42 Min.: 18 Mean: 27	Max.: 34 Min.: 20 Mean: 28	2.57 : 1	Max.: 101.6 Min.: 99.8 Mean: 100.9	Max.: 102.1 Min.: 100.4 Mean: 101.4	Max.: 1038 Min.: 1032 Mean: 1034
70 (Ayrshire) Born 7.9.36. Last calving 29.5.41.	594 (3.67%) 623 (3.51%)	Max.: 81 Min.: 60 Mean: 70	Max.: 36 Min.: 18 Mean: 27	Max.: 43 Min.: 23 Mean: 28	2.50 : 1	Max.: 101.4 Min.: 99.7 Mean: 100.7	Max.: 101.8 Min.: 99.8 Mean: 101.3	Max.: 1038 Min.: 1032 Mean: 1033
71 (Ayrshire) Born 14.9.36. Last calving 5.3.41.	956 (3.35%) 701 (3.40%)	Max.: 80 Min.: 68 Mean: 72	Max.: 43 Min.: 18 Mean: 29	Max.: 34 Min.: 20 Mean: 28	2.57 : 1	Max.: 101.8 Min.: 99.8 Mean: 100.8	Max.: 102.1 Min.: 100.2 Mean: 101.2	Max.: 1029 Min.: 1023 Mean: 1026
77 (Dairy Shorthorn-Ayrshire X) Born 1936. Last calving 10.12.40.	3 previous calves (no recording)	Max.: 78 Min.: 62 Mean: 63	Max.: 50 Min.: 19 Mean: 32	Max.: 40 Min.: 26 Mean: 30	2.10 : 1	Max.: 101.6 Min.: 99.4 Mean: 100.8	Max.: 101.9 Min.: 100.0 Mean: 101.4	Max.: 1036 Min.: 1029 Mean: 1032
86 (Dairy Shorthorn-Ayrshire X) Born 1937. Last calving 28.1.41.	(no recording)	Max.: 75 Min.: 58 Mean: 69	Max.: 45 Min.: 21 Mean: 30	Max.: 37 Min.: 24 Mean: 30	2.30 : 1	Max.: 101.8 Min.: 99.3 Mean: 100.9	Max.: 102.0 Min.: 100.5 Mean: 101.4	Max.: 1039 Min.: 1033 Mean: 1036
87 (Ayrshire) Born 6.1.37. Last calving 31.12.40.	968 (4.12%)	Max.: 75 Min.: 61 Mean: 67	Max.: 48 Min.: 20 Mean: 32	Max.: 45 Min.: 22 Mean: 30	2.23 : 1	Max.: 101.3 Min.: 99.1 Mean: 100.7	Max.: 101.9 Min.: 100.1 Mean: 101.1	Max.: 1036 Min.: 1029 Mean: 1031
90 (Ayrshire) Born 11.3.37. Last calving 25.2.41.	654 (3.89%) (twin calves)	Max.: 80 Min.: 58 Mean: 74	Max.: 38 Min.: 14 Mean: 26	Max.: 32 Min.: 23 Mean: 28	2.64 : 1	Max.: 102.8 Min.: 99.5 Mean: 101.0	Max.: 102.2 Min.: 99.5 Mean: 101.2	Max.: 1030 Min.: 1020 Mean: 1026
94 (Ayrshire) Born 11.5.37. Last calving 6.4.41.	1,121 (3.70%)	Max.: 76 Min.: 61 Mean: 69	Max.: 39 Min.: 19 Mean: 27	Max.: 37 Min.: 19 Mean: 27	2.56 : 1	Max.: 101.5 Min.: 99.2 Mean: 100.7	Max.: 102.0 Min.: 100.0 Mean: 101.3	Max.: 1039 Min.: 1034 Mean: 1036

continued

Liveweight (kg.)	Daily Milk Yield (lbs.)	% B.F. (weekly pooled samples)	% T.S. (weekly pooled samples)	Cudding chews/ minute	Cudding chews/ bolus	Grazing Bites (freq/ minute)	Health Index	Remarks
Max.: 559.3 Min.: 493.0 Mean: 528.2	Max.: 22.5 Min.: 6.0	Max.: 4.7 Min.: 3.5	Max.: 13.3 Min.: 11.8	Mean: 63	Mean: 47	Mean: 80	Max.: 7.5 Min.: 5.5	
Max.: 619.6 Min.: 597.8 Mean: 609.1	Max.: 18.3 Min.: 4.0	Max.: 3.1 Min.: 1.8	Max.: 10.5 Min.: 8.4	Mean: 72	Mean: 44	Mean: 69	Max.: 7.0 Min.: 5.0	
Max.: 520.7 Min.: 489.0 Mean: 501.2	Max.: 38.3 Min.: 18.0	Max.: 3.8 Min.: 2.6	Max.: 1 Min.: 11.3	Mean: 66	Mean: 61	Mean: 77	Max.: 5.9 Min.: 4.1	
Max.: 561.6 Min.: 508.9 Mean: 536.6	Max.: 23.5 Min.: 4.5	Max.: 4.2 Min.: 2.2	Max.: 12.1 Min.: 10.3	Mean: 56	Mean: 46	Mean: 83	Max.: 7.5 Min.: 4.9	Slight s/c œdamatous swelling above L. H. quarter, 16.9.41.
Max.: 578.8 Min.: 539.8 Mean: 560.7	Max.: 21.0 Min.: 11.3	Max.: 4.4 Min.: 3.8	Max.: 13.4 Min.: 12.6	Mean: 62	Mean: 49	Mean: 79	Max.: 7.5 Min.: 4.8	
Max.: 557.5 Min.: 524.4 Mean: 548.0	Max.: 23.3 Min.: 8.8	Max.: 4.5 Min.: 3.3	Max.: 13.2 Min.: 11.8	Mean: 60	Mean: 41	Mean: 81	Max.: 7.9 Min.: 5.4	Horn-gore on R. H. quarter, 23.8.41.
Max.: 534.8 Min.: 495.8 Mean: 513.9	Max.: 19.5 Min.: 11.3	Max.: 4.3 Min.: 2.2	Max.: 12.7 Min.: 11.1	Mean: 61	Mean: 42	Mean: 83	Max.: 7.3 Min.: 3.6	Served 23.8.41.
Max.: 557.0 Min.: 510.7 Mean: 536.6	Max.: 8.0 Min.: 0.5	Max.: 3.8 Min.: 2.2	Max.: 11.7 Min.: 9.8	Mean: 63	Mean: 40	Mean: 66		Slight mastitis, 22.3.41.
Max.: 449.0 Min.: 432.7 Mean: 449.1	Max.: 15.5 Min.: 5.0	Max.: 4.7 Min.: 3.0	Max.: 13.4 Min.: 11.9	Mean: 62	Mean: 45	Mean: 83		Œdmatous s/c swelling, posterior aspect R. H. quarter, 26.8.41.
Max.: 449.0 Min.: 451.8 Mean: 481.3	Max.: 25.3 Min.: 5.5	Max.: 5.1 Min.: 3.2	Max.: 14.5 Min.: 12.2	Mean: 65	Mean: 49	Mean: 67	Max.: 6.6 Min.: 4.8	
Max.: 545.2 Min.: 495.3 Mean: 526.2	Max.: 14.5 Min.: 4.0	Max.: 5.1 Min.: 3.1	Max.: 13.2 Min.: 12.1	Mean: 54	Mean: 45	Mean: 71	Max.: 7.8 Min.: 3.9	
Max.: 483.5 Min.: 458.0 Mean: 465.8	Max.: 17.3 Min.: 8.0	Max.: 5.2 Min.: 3.5	Max.: 14.1 Min.: 12.3	Mean: 59	Mean: 42	Mean: 78		
Max.: 546.6 Min.: 508.9 Mean: 526.6	Max.: 22.0 Min.: 8.0	Max.: 4.6 Min.: 2.8	Max.: 13.0 Min.: 11.2	Mean: 64	Mean: 59	Mean: 79	Max.: 6.4 Min.: 4.0	

Continued over

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TABLE I—

Animal	Previous Lactations (Yield in gallons, and B.F.)	Heart-Rate (p.m.)	Respiration Rate (a.m.)	Respiration Rate (p.m.)	Ratio Heart : Resp. (p.m.)	Rectal Temp. (a.m.)	Rectal Temp. (p.m.)	Urine Sp. gr.
96 (Ayrshire) Born 15.6.37. Last calving 29.1.41.	1,218 (3.65%)	Max.: 86 Min.: 62 Mean: 70	Max.: 54 Min.: 19 Mean: 33	Max.: 41 Min.: 25 Mean: 30	2.34 : 1	Max.: 101.7 Min.: 99.6 Mean: 100.9	Max.: 102.3 Min.: 100.3 Mean: 101.3	Max.: 1025 Min.: 1019 Mean: 1022
97 (Ayrshire) Born 19.6.37. Last calving 23.4.41.	719 (3.65%)	Max.: 75 Min.: 63 Mean: 70	Max.: 41 Min.: 18 Mean: 27	Max.: 36 Min.: 21 Mean: 28	2.50 : 1	Max.: 101.6 Min.: 99.4 Mean: 100.8	Max.: 102.1 Min.: 99.8 Mean: 100.8	Max.: 1028 Min.: 1022 Mean: 1026
102 (Ayrshire) Born 30.9.37. Last calving 3.3.41.	1,084 (3.89%)	Max.: 80 Min.: 62 Mean: 71	Max.: 47 Min.: 18 Mean: 31	Max.: 37 Min.: 21 Mean: 28	2.54 : 1	Max.: 101.6 Min.: 99.2 Mean: 100.7	Max.: 102.4 Min.: 100.6 Mean: 101.4	Max.: 1022 Min.: 1014 Mean: 1017
104 (Ayrshire) Born 6.11.37. Last calving 5.4.41.	796 (3.59%)	Max.: 78 Min.: 62 Mean: 70	Max.: 41 Min.: 20 Mean: 27	Max.: 39 Min.: 19 Mean: 27	2.59 : 1	Max.: 101.4 Min.: 99.4 Mean: 100.6	Max.: 102.0 Min.: 100.8 Mean: 101.2	Max.: 1031 Min.: 1024 Mean: 1026
105 (Ayrshire) Born 24.11.37. Last calving 17.5.41.	558 (3.66%) (but lactation closed early, see text)	Max.: 84 Min.: 68 Mean: 76	Max.: 43 Min.: 18 Mean: 30	Max.: 36 Min.: 21 Mean: 28	2.71 : 1	Max.: 101.6 Min.: 99.8 Mean: 100.8	Max.: 102.0 Min.: 100.1 Mean: 101.3	Max.: 1045 Min.: 1031 Mean: 1039

continued

Liveweight (kg.)	Daily Milk Yield (lbs.)	% B.F. (weekly pooled samples)	% T.S. (weekly pooled samples)	Cudding chews/ minute	Cudding chews/ bolus	Grazing Bites (freq/ minute)	Health Index	Remarks
Max.: 546.1 Min.: 481.7 Mean: 521.2	Max.: 26.8 Min.: 13.3			Mean: 65	Mean: 50	Mean: 73	Max.: 6.5 Min.: 4.1	
Max.: 489.0 Min.: 457.2 Mean: 472.7	Max.: 27.5 Min.: 12.0	Max.: 4.3 Min.: 3.2	Max.: 13.2 Min.: 12.0	Mean: 65	Mean: 46	Mean: 70	Max.: 6.5 Min.: 4.8	Bad neighbour to 104; many "Xs" in irritability tests.
Max.: 604.2 Min.: 548.4 Mean: 550.2	Max.: 31.5 Min.: 11.8	Max.: 4.8 Min.: 3.1	Max.: 13.6 Min.: 12.0	Mean: 64	Mean: 53	Mean: 80	Max.: 7.4 Min.: 6.1	Always an excitable animal. Slight mastitis, 22.3.41. Injury R. F. pastern, 15.9.41. Many "Xs" in irritability tests.
Max.: 480.8 Min.: 430.9 Mean: 458.1	Max.: 24.5 Min.: 10.8	Max.: 4.7 Min.: 3.1	Max.: 13.7 Min.: 11.7	Mean: 63	Mean: 45	Mean: 72	Max.: 6.8 Min.: 4.5	
Max.: 428.9 Min.: 399.2 Mean: 413.2	Max.: 29.0 Min.: 18.5	Max.: 4.2 Min.: 2.6	Max.: 13.0 Min.: 11.0				Max.: 5.6 Min.: 3.1	See text. "Foul of the foot" flared up on 18.9.41.

Continued from page 87

quent lactations. These facts should be borne firmly in mind when attempts are being made to evaluate the results of nutritional experiments. The question of "nutritional status" has recently received much attention, as was evident at the first discussion of the new Nutrition Society. We feel that studies of the type reported here provide ample opportunities for the veterinarian to make his contribution to problems which are of outstanding importance to the whole animal industry.

Summary

Ayrshire and Dairy Shorthorn-Ayrshire cows were carefully studied during a two-months' period in which they were the subjects of a nutritional experiment. A fairly extensive series of physiological observations was undertaken, and an attempt was made to form a true picture of the health of each individual. A tentative "health index" was assigned to each animal at intervals throughout the experiment.

The necessity of utilising such data in the interpretation of nutritional experiments is emphasised.

While the actual figures obtained are not put forward as necessarily representing the "normal" for the species or breed involved, the following mean values, obtained from 25 or 26 animals* in various stages of lactation (daily milk-yields of from 0.5 to 38.3 lbs.) are put on record for comparative purposes:—

Heart-rate (p.m.)	70/minute
Respiration-rate (a.m.)	29.6/minute
Respiration-rate (p.m.)	28.7/minute
Ratio of heart-rate to respiration-rate (p.m.) ...	2.44 : 1
Rectal temperature (a.m.)	100.5 deg. Fahr.
Rectal temperature (p.m.)	101.3 deg. Fahr.
Urinary sp. gr.	1030
Cudding (frequency)	62/minute
Cudding (per bolus)	47
Grazing bites	74/minute

Attention is drawn to the inadequacy of certain text-book data relating to physiological values for dairy cattle, and in particular to relating to heart-rate and respiration rate.

It is suggested that a study of the factors governing the development and control of the condition known as "foul of the foot" would be of economic importance to the dairy industry.

*Some of data for cow 35 have been omitted, as the mean values in her case were obviously affected by her illness.

TABLE II

Details of Byre and Pastures

Byre: Double building, each part holding 40 animals. Yoke-tie fastenings. Animals in two rows, facing one another. Findlay system of ridge ventilation. Automatic watering bowls.

Pastures:

Number	*Size*	*Soil*	*Aspect*	*Seed Mixture*	*Year of Laying*
8	14½ acres	Medium loam	Southerly slope	(a) below	1940
9	9½ acres	do.	do.	do.	do.
13	10 acres	do.	do.	do.	do.
70	8¼ acres	do.	Northerly slope	(b) below	1939

Seed Mixture (a)		*Seed Mixture (b)*	
Irish Perennial Rye	16 lbs. per acre	(do.)	14 lbs. per acre
Italian Rye	4 „ „ „	(do.)	4 „ „ „
Danish Cocksfoot	4 „ „ „	(do.)	3 „ „ „
Swedish Cocksfoot	4 „ „ „	(do.)	3 „ „ „
Scottish Timothy	2 „ „ „	(do.)	2 „ „ „
Broad-leaf Red Clover	2 „ „ „	(do.)	3½ „ „ „
Late-flowering Red Clover	2 „ „ „	Montgomery Red Clover	1½ „ „ „
Wild White Kent Clover	½-lb. „ „	(do.)	¾-lb. „ „

(*Table III overleaf.*)

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TABLE III

Summary of Certain Physiological Data recorded for the Dairy Cow

Animals	Heart-Rate (*per minute*)	Respiration Rate (*per minute*)	Ratio of Heart to Respiration Rate	Rectal Temperature	Cudding	Author
63 housed dairy cows; non-reactors to tuberculin test	—	—	—	100.4 to 102.8 deg. F. (38 to 39.30 deg. C.) Mean: 101.4 deg. F. (38.5 deg. C.)	—	Wooldridge (1905)
37 housed dairy cows, presumably healthy. Some pregnant, some non-pregnant —	—	—	—	*Morning* (8 a.m.) Mean: 102 deg. F. (38.8 deg. C.) *Afternoon* (4 to 5 p.m.) Mean: 101.5 deg. F. (38.6 deg. C.)	—	Wooldridge (1905)
2 dry Jerseys	—	—	—	100.2 to 102.2 deg. F. (37.8 to 39 deg. C.) A gradual rise in body temperature between 2.30 and 5 p.m.	—	Kriss (1921)
8 Ayrshires (housed for data recorded in first three columns	52 to 90 Mean: 69.6	14 to 56 Mean: 28.6	2.43 : 1	—	(5 animals only) Averages, 52-62 Mean: 59/minute	Fuller (1928)
7 Guernseys (ditto)	48 to 72 Mean: 59.8	12 to 51 Mean: 18.6	3.2 : 1	—	(3 animals only) Averages, 47-58 Mean: 52/minute	Fuller (1928)
15 Holsteins (ditto)	51 to 96 Mean: 68.6	12 to 69 Mean: 28.6	2.4 : 1	—	(8 animals only) Averages, 50-58 Mean: 56/minute	Fuller (1928)
9 Jerseys (ditto)	38 to 84 Mean: 62.7	11 to 64 Mean: 21.7	2.8 : 1	—	(4 animals only) Averages, 46-56 Mean: 53/minute	Fuller (1928)
7 Holsteins and 4 Jerseys (Housed; other conditions varying)	Averages, 36 to 56; Mean: 47	—	—	99 to 102.2 deg. F. (37 to 39.2 deg. C.) Mean: 100.8 deg. F. (38.2 deg. C.)	—	Ritzman & Benedict (1938)
9 stall-fed animals	—	—	—	—	Chews per bolus: Range: 21-114 Mean: 59 (10 counts per animal)	Brownlee, (1939)
19 Ayrshires and 7 Dairy Shorthorn-Ayrshire crosses (Housed for data in first 4 cols.)	Averages, 63 to 80; Mean: 70.4	*Morning* (5.30 to 5 a.m.) Averages, 26 to 38; Mean: 29.6		*Morning* (3.30 to 5 a.m.) Mean: 100.5 deg. F. (38.1 deg. C.)	(25 animals only) Averages, 54-72 Mean: 62/minute	Grant, Milla and Worden (1942)
		Afternoon (2.45 to 4 p.m.) Averages, 26.5 to 46; Mean: 28.7	*Afternoon* (2.45 to 4 p.m.) Mean: 2.44 : 1	*Afternoon* (2.45 to 4 p.m.) Mean: 101.3 deg. F. (38.5 deg. C.)	Chews per bolus: Averages, 39-61 Mean: 47	

EMBRYONAL NEPHROMA IN THE DOMESTIC FOWL

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APART from lymphocytomas and other closely allied conditions, neoplasms involving the kidney of the fowl are of comparatively rare occurrence. Hedren[1] describes an adenomyosarcoma with bone formation, and remarks that a tumour of similar nature occurs in human pathology. Fox[2] has reported twelve primary tumours of kidneys in birds, all of which occurred in a zoological garden. He does not mention any cases in domestic fowls. Five of his cases were papillary adenomatous tumours with cyst formation, or the production of solid nests of epithelial cells, with no acinous or duct formation. Mathews[3] has recorded twelve adenosarcomata out of fifty-five renal tumours discovered in the course of two thousand post-mortem examinations. His specimens were attached to the periosteum of the spinal column and were separated from the kidney by a fibrous capsule. In all cases the left kidney was involved. McKenny[4] had two cases of embryonal carcinoma in white leghorn hens. These grew within the kidney, were not encapsulated, and not attached to the spinal column. There were no metastases and the tumours were unilateral. Macroscopically, they showed areas of hæmorrhage and necrosis, with bands of fibrous tissue running through the mass. In one case there were large masses of undifferentiated cells; in the other, definite tubular and glomerular-like structures were seen. There were many large cysts containing colloid-like material and lined with flattened epithelial cells.

Eber and Malke[5] report sixteen cases of kidney tumours in fowls, including eleven sarcomas, one carcinoma, and two adenomas.

Feldman and Olson[6] had one case of bilateral embryonal tumour in a cross-bred hen aged 10 months, used as a subject for transmission experiments with erythroleucosis, and which died from this disease. Their specimen, which they classified as an adenosarcoma, was characterised by a variety of cellular elements.

They reported that adenomatous structures were common, cells of many of these having undergone keratinization, with formation of numerous cornified nodules.

From the foregoing it will be seen that the histological picture of this interesting tumour varies considerably, and it was therefore thought desirable to place on record a further case of this by no means common condition.

Post-Mortem 7883

The present case occurred in a white leghorn hen aged 18 months. This bird appeared normal until it was frightened and jumped from a high shed roof, making an awkward landing and appearing to hurt its left leg. When examined, the limb showed a partial spastic paralysis, and the bird could walk only with difficulty. A focus of pain was thought to be detected at the tibio-tarsal joint, and severe sprain was diagnosed. The joint was mildly stimulated with Ung. Iodi. and temporarily immobilised with a light Cellona P.O.P. dressing.

The bird, however, showed a progressive deterioration in condition, and

as at the end of nine days it was completely unable to use either leg, it was destroyed and autopsied.

Subject was in moderate condition, weighing 4 lb. The left sciatic nerve was found to be enlarged for about 3 cm. of its length in its course down the thigh. This was the only abnormality in the peripheral nervous system which could be detected macroscopically.

On removing the abdominal viscera, a whitish firm growth was seen involving the mesial aspect of the anterior lobe of the right kidney, which was enlarged. Cranial to this, i.e., immediately lateral to the ovarian attachment, was a subcapsular hæmorrhage. (See Fig. 1). There was no attachment to the spinal periosteum.

A longitudinal section of the growth and anterior pole of the kidney showed it to have a well marked capsule separating it from the renal tissue, which was compressed. The presence of this capsule negated the idea of lymphocytoma of the kidney.

The dimensions of the growth were 23 by 20 by 18 mm. It was firm, and yellowish-white on the cut surface. There were areas of compact tissue, areas of hæmorrhage and necrosis, and areas of small cysts.

L.S. Anterior Pole Right Kidney

Microscopical examination of frozen sections of the left sciatic nerve failed to show any infiltration with round cells. Instead, there were areas of hæmorrhage and degeneration in the swollen part, suggesting traumatism.

Histological Features of Renal Tumour

A description of the microscopical picture of the tumour can conveniently be divided into three parts corresponding roughly with the three areas already mentioned, i.e., cystic, hæmorrhagic and solid.

The first area consists of irregular vesicles or cysts of various sizes, lined with epithelium ranging from flattened cubical to columnar cells, and containing homogeneous colloid-like substance staining pink with eosin, but not with toluidin blue. This substance is therefore not epithelial hyalin or mucin. The epithelium frequently projects into the lumina of the vesicles in a papilliform manner. (Fig. 2.)

Separating the walls of the vesicles is a celullar stroma in which lie many acinar groups of cells having the appearance of sections of straight renal tubules, together with small blood vessels, etc. Some of these tubules contain the same colloid-like material, whilst others have a definite lumen. It seems probable that the large vesicles are simply cystic tubules. With higher magnification the cells composing both tubules and walls of cysts are seen to have vesicular nuclei, and the cytoplasm to have a dark "brush" border next to the lumen. Small clear vacuoles at the edge of the colloid mass appear to be analogous to the secretion vacuoles in the thyroid gland.

The stroma is composed of a preponderance of cells resembling young connective tissue cells, together with a few mature fibroblasts with their elongated deeply staining nuclei. Many delicate capillaries lie amongst these cellular intercystic groups.

The solid yellowish-white areas exhibit a more undifferentiated appearance.

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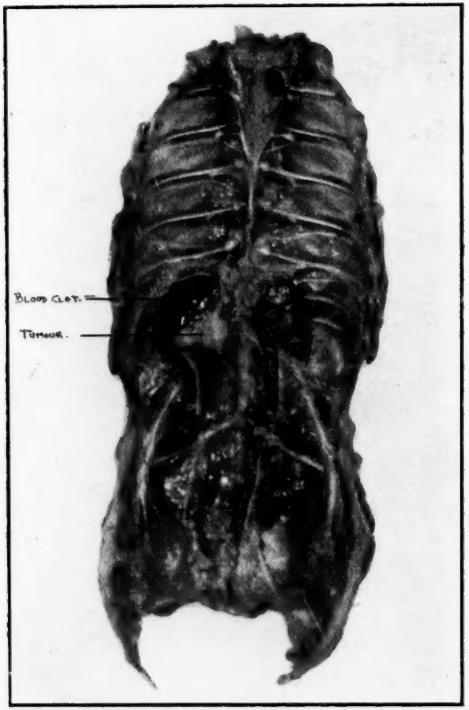
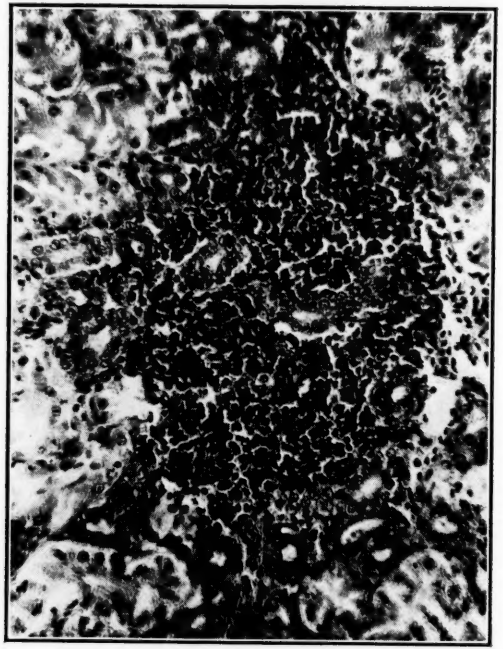


1. Embryonal Nephroma. Right kidney x ½

2. Section of cystic area. Renal tumour x 100.

3. Cellular part, showing sarcomatous appearance tubule formation and a portion of the fibrous capsule x 160.



4. Cell group in left kidney showing possible tubule formation x 390.

There is a great abundance of cellular tissue, for the main part structureless, but here and there forming tubule-like structures, some of which are enlarging to form cysts. (Fig. 3.)

The component cells are exactly as already described in the intercystic stroma, and remind one of sarcomatous tissue, but judging from the scarcity of mitotic figures and the other findings, the neoplasm appears to be of a benign character.

The whole tumour is surrounded by a comparatively thick (1 mm.) fibrous tissue capsule, beyond which the renal tissue shows signs of compression from the growing mass.

The left kidney was also sectioned, and examination of several slides taken from the upper lobe shows isolated masses of cells characterised by darkly staining irregular nuclei, with the chromatin arranged in clumps, surrounded by a moderately extensive zone of cytoplasm. Interspersed with these, but in smaller numbers, are cells with lighter staining vesicular nuclei, with the chromatin tending to form a narrow ring within the nuclear membrane. These cells are provided with a moderate cytoplasm. Some of them appear to be arranged in the form of acini. The possibility that here we have a group of embryonic epithelial and mesenchymal cells, just commencing to develop into a similar type of tumour to that already described, makes these sections particularly interesting. (See Fig. 4.)

The above mentioned post-mortem and histological findings suggest that the condition is one of embryonal nephroma.

Other Cases

One other case of embryonal nephroma has so far been observed in the fowl. This was definitely sarcomatous in character, as compared with the adenomatous type just described. The following renal tumours have also been diagnosed in other species of birds :—

Mixed hypernephroma and adeno-carcinoma, with a certain amount of spicular bone formation in a sulphur-crested cockatoo (cf. Hedren's case).

Two embryonal adeno-sarcomas from budgerigars and a doubtful spindle cell sarcoma from another bird of the same species. (It seems possible that the latter case developed as the result of renal irritation from some sort of parasite, unidentifiable portions of which were found in the neoplasm, and therefore the condition may have been a connective tissue hyperplasia.)

Etiology of the Tumour

Embryonal nephromata, when found in human beings (children) are called Wilms's tumours. They have also been reported in rabbits and pigs.

Wilms's view is that they develop from a fœtal rest or displacement, that they develop from the same type of embryonic cell, and, according to the stage of development of this cell, exhibit various histological features, e.g., if they develop from a comparatively undifferentiated cell, the resulting tumour shows a fairly complicated structure, because of the multipotency of undifferentiated mesodermal cells. The final tumour, on the other hand, may be of a simple nature having developed from a more differentiated embryonic cell.

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Summary

An embryonal nephroma occurring as a unilateral tumour in the kidney of a white leghorn hen aged 18 months is described, together with a possible stage of development of the same type of tumour in the other kidney. Other reported cases are noted, and the probable etiology mentioned.

Acknowledgments

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Abstracts of Current Literature

Phenothiazine Poisoning in Pigs. By W. M. Thorning, C. C. Morrill and L. E. Boley. *Vet. Med.*, 1942. *XXXVII,* 120.

The authors describe phenothiazine poisoning in 112 pigs, which were overdosed. The pigs had just been weaned, and weighed from 10 to 30 lb.—average 20 lb. They were starved for thirty hours and then were fed a "corn and oat slop" to which had been added 909 gm. of phenothiazine. Theoretically, the dose received by each pig was 8.11 gm., i.e., almost twice the prescribed dose of 0.5 gm. per kilogram body weight. The first evidence of poisoning was seen within five hours, and by ten hours only twelve of the pigs were able to stand. The symptoms were those of a nervous derangement. There was inco-ordination with marked weaving of the hind quarters. Some of the animals showed complete posterior paralysis, and, when down, unable to rise; some made running movements as they lay on their sides. Some were semi-comotose. In many, the appetite was fairly good and even those showing posterior paralysis ate and drank eagerly when supported at the trough. External corneal opacity is reported in many of the animals, 48 hours after treatment. In the majority the blindness was temporary, recovery being complete before the sixteenth day, though six are said to have taken a longer time to recover their sight. Both unilateral and bilateral keratitis are reported. The temperature of five pigs was taken and varied from 98.4 deg. F. to 100.8 deg. F. Blood samples from three pigs taken on the day following the treatment failed to reveal abnormality. Two pigs only, died. They are described at "runts." By the second day after

the dosing all but twenty-six of the pigs were on their feet again. Post-mortem examination on one of the pigs which died showed a diffuse yellow discoloration of the liver. In discussing the case, the authors say: "This experience and others reported in the literature indicate the advisability of care in the use of phenothiazine in swine. The weights of the animals should not be estimated but representative individuals should be weighed, and the dosage accurately determined. Individual treatment by capsule or with a suspension of the drug should provide a higher degree of safety. If it is desired to mix the drug in the feed, it would be well to separate the pigs into groups on the basis of size before feeding."

Iodized Mineral Oil in Bovine Mastitis. By D. M. SAUNDERS. *North Amer. Vet. 23,* 195.

THE author reports that: "Tests on a limited number of animals showed that a 1 : 1,000 to 1 : 1,500 solution of U.S.P. resublimed iodine crystals in U.S.P. liquid petrolatum (heavy medicinal mineral oil) has valuable therapeutic properties as a treatment for mild udder infections. It is injected into the lactating quarter via the teat canal.

"A number of infected quarters injected once with from 100 to 300 c.c. ceased to excrete micro-organisms associated with mastitis. Local reaction was produced with the appearance of erythrocytes in the milk. In some instances the milk flow was reduced. There was a return to normal within ten days."

In this country the value of such a solution of iodine has been recognised but its use has been confined largely to that of a liniment. The vehicle favoured being B.P. liquid paraffin. The method of preparation is to put ℥i resublimed iodine crystals in a Winchester bottle and fill up with liquid paraffin. Solution is rather slow. The resulting solution can be used in a variety of instances in which one wishes to combine the beneficial effects of massage and the resolvement properties of iodine. The fact that this solution also appears to possess certain bacteriostatic properties would encourage one to repeat Saunders' tests.

A Review of the Animal Tuberculosis Situation in North Carolina at the Present Time. North Amer. Vet. 1942. *23,* 149.

WILLIAM MOORE, State Veterinarian, North Carolina Department of Agriculture, gives some interesting information in this article.

North Carolina inaugurated its campaign for the control of bovine tuberculosis 24 years ago. Testing was begun in 1918 by the Veterinary Division of the N.C. Department of Agriculture in co-operation with the U.S. Bureau of Animal Industry.

Area plan testing commenced in 1921 and was completed in 1928.

North Carolina had not a high incidence of infection but the success of the control programme is illustrated in official reports for the year 1941.

One thousand seven hundred and fifty herds, containing 35,828 head of cattle, were tested. Only four reactors were found and they were all in one herd.

It would appear that control measures have been highly successful and that tuberculosis has been irradicated to all intents and purposes. The writer considers that the control programme should be continued indefinitely, especially as all

methods of spread are not known and that cattle have little, if any, immunity to the disease. Present-day methods of marketing might result in widespread infection if control were relaxed.

The results shown are an excellent omen for the future. There should be no reason why the North Carolina results should not be repeated elsewhere.

Silver Picrate in the Treatment of Granular Vaginitis in Cattle. By R. L. Brown. *North Amer. Vet.* 1941. *22*, 247.

Author stresses the seriousness of this disease. He found it in 16 herds, involving 1,500 head. In most of these herds it was more serious than Bang's disease.

As regards differential diagnosis two main diseases may be confused with granular vaginitis, i.e., Bang's disease and trichomoniasis. They may be eliminated by blood testing and microscopical examination of the discharge from the vagina and from the sheath of the bull. The author has found that one per cent. silver picrate powder dispersed in kaolin gives good results in treatment. He advises that the vagina be dusted three times a week. Breeding should be stopped during the period of treatment.

He gives records of results in 16 herds. In the case of infected bulls he finds that rest, for two to four months or longer, alone will stop the infection, and if necessary recommends injections of ascorbutic acid to restore fertility.

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